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ALTERNATIVE AND SUPPLEMENTAL ENERGY PROJECTS AND ACTIVITIES OF RURAL ELECTRIC SYSTEMS IN THE UNITED STATES

By

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INTRODUCTION

Since the oil embargo of 1973, the whole world has been aware of the fact that oil is an exhaustible resource and that there is a need to search for and harness new sources of energy to sustain the world and provide for a secure energy future.

The late 1970's saw an intense effort of this kind in the United States which (although sometimes poorly managed) was well-intentioned and accomplished some significant forward progress.

Some[1] of the new energy sources which were specified, examined and explored (in terms of acting as alternatives and supplements to our present energy resources (oil coal, and nuclear) in the United States) were:

Biomass Derived Fuels
Geothermal Energy
Small, Hydroelectric Energy
Solar Energy
Synfuels
Wind Energy

In the 1980's we find that we no longer have the financial resources to explore all of the possible options, but that we must be more practical and search for options which have real near-term potential.

In Rural America (where many of the adventuresome, innovative and practical-minded people of the United States live and where these persons seem to have a knack for making a machine or device function in a new or innovative way) the exploration of new energy sources continues relatively unabated.

However, there is a new twist. The goal of these projects seems to be to get a device or process working and producing energy, rather than to perform a study. Let me say that we all see this emphasis on practical results-producing processes and equipment as a healthy and desirable trend.

Rural Electric Systems, represented by their national trade association, NRECA, and serving 70% of the land mass of the United States, are right in the thick of these continuing efforts.

Let us take a tour through some of these activities. Note that we will have to confine ourselves to projects which the Rural Electric Utility is funding and/or has direct involvement in.[2]

AUTHOR'S NOTE

Before we start, let us take a moment to clarify our language. There are two words commonly used as descriptions for these new types of energy technologies and resources. The words are Alternative and Supplemental.

From a utility standpoint, an Alternative Energy Source or process is one that has the capability of substituting for a conventional electric generating plant. Therefore it must be completely reliable and dispatchable.

There are a number of New Energy Technologies which do not have these characteristics (because of the nature of the resource they depend upon) without some sort of storage system which, at present, is very expensive. We must call these processes or resources Supplemental. That is to say, that they can supplement the present electric energy generation system, but cannot act as alternatives.

Processes and resources which we see as being "Supplemental" are:

Wind Energy

Solar Energy

Processes and resources which we see as being "Alternative" are:

Biomass

Geothermal

Some Small Hydroelectric (with impoundment)

Synfuels

BIOMASS ENERGY[3]

As already implied, Biomass energy has potential as an Alternative Energy Source for Rural Electric Systems in the United States and is being explored by those systems. Let us look at some of the ways it is being explored and/or used as an energy option there.

Biogas

In the late 1970's at the Alaska Village Electric Cooperative (with its headquarters in Anchorage, Alaska and serving some 40 Alaskan villages all over the State of Alaska) the cost of producing electric energy by diesel generation was becoming prohibitive. The manager of the cooperative began to search for an alternative.

Together with the State of Alaska, the cooperative financed the production of a wood-waste-fueled-biogas production unit which could be hooked up to a diesel generator and, with modifications, fuel that generator. The 150kW gasifier was produced by a company in California and moved to Anchorage for test operations.

Tests proved to be successful and the coop, together with Morenco (a local engineering firm) and the State of Alaska, is now working on plans to build a 250kW unit to be installed at an appropriate location in the state.

At Guadeloupe Valley Electric Cooperative in Gonzales, Texas, one of the main industries of their service territory is the production of broiler chickens. The Cooperative estimates that they have over 175,000 tons of chicken manure produced by this industry every year. They would like to take this manure and anaerobically digest it to gas which would provide a substantial local energy supply. They are presently running tests on the suitability of this material to produce gas at a nearby university test facility. If all goes well, they would like to build a plant which could provide from 20-30 Megawatts of peaking power in their service territory.

Liquid Fuels from Biomass

At Alabama Electric Cooperative in Andalusia, Alabama, there is an obsolete old coal-fired, three boiler, steam-electric power power plant with a capacity of 40 Megawatts which the Cooperative does not operate most of the time, because of its inefficient operating characteristics (with respect to their newer, larger plants). Their plan is to use one or more of the boilers at the plant to produce steam to distill alcohol produced from local grain. The plant production is estimated at 20 million to 40 million gallons per year, and the finished stillage from the fermenting process will be used as a high grade cattle feed supplement. The alcohol would be used to produce high octane unleaded gasoline (gasahol).

The Cooperative has purchased 40 acres as a site next to the power plant and is seeking a partner (in the form of an oil or chemical company) to co-finance the project.

The National Rural Electric Cooperative Association in Washington, D.C. and East River Electric Power Cooperative in Madison, South Dakota, have for a number of years been supporting a project to produce alcohol from waste materials at South Dakota State University in Brookings, South Dakota.

The process involves the breeding of special bacteria (similar to those found in the stomach of a cow), which break down the cellulose in materials like old newspapers, corncobs, grain chaff, etc.), involves using the bacteria to convert the cellulose to starches and sugars. These can, in turn, be fermented into alcohol. The project has moved from a batch production operation to a continuous flow-through process (which is what is needed) in an industrial sized operation. Things look promising.

At Swisher Electric Cooperative in Tulia, Texas the local economy has suffered seriously during the last several years with a depression of the grain market and the slowdown in the economy. The Cooperative, both for the purpose of stimulating the local economy, and in order to assist the United States in becoming more energy self-sufficient, has plans to build an alcohol fuels plant of 40,000 gallons per year.

One of the feedstocks for the plant is a substantial accumulation of outdated seed milo which, at present, has little value. The stillage would be used as a high-quality livestock feed supplement.

At present the Cooperative is seeking financial partners and is commencing site preparation. They plan to have the plant operating by Summer 1983.

At Verendrye Electric Cooperative in Velva, North Dakota (where sunflowers are a very large local crop) there is a substantial amount of sunflower oil available.

The Cooperative, remembering the oil embargo of 1973 and the importance of the continuity of agriculture and ensuring a supply of fuel for the local farm machinery, has been involved with and is helping to finance a project at North Dakota State University in Fargo to fuel tractors and other farm machinery (which normally run on diesel) on sunflower oil.

Results so far are encouraging. The sunflower oil seems to be almost as high an energy content fuel as diesel and can be readily produced on a small scale by local farmers with a press and filter. However, it is still expensive to produce and has a much higher viscosity than diesel oil in cold weather.

Testing also continues to see what impact sunflower oil has on the long-term life of a diesel engine.

Waste/Biomass Fueled Steam Electric Generation

At Basin Electric Power Cooperative (with its headquarters in Bismarck, North Dakota and its power supply responsibility for a part of 8 states) there is another old, inefficient, small coal-fired power plant.

One of the major crops in the area is sunflower seeds. The process of producing sunflower oil and other products from these seeds produces a great deal of waste material in the form of hulls.

Basin, in 1979, decided to test the feasibility of utilizing these hulls as a supplemental fuel in the "Neal" generating station. The tests showed that the hulls had good handling characteristics and almost a high a BTU content as the lignite coal the plant was using as a prime fuel.

Basin accepted a proposal from a sunflower processor in 1980 to build a sunflower processing plant next to the plant. The plant is providing the processor with waste heat from its boilers and, in exchange, is receiving sunflower hulls as a supplemental fuel. The plant has been built and the tandem operation of the two facilities is running, making this one of the world's first biomass fueled cogeneration operations.

For several years now at the French Broad Electric Membership Corporation in Marshall, North Carolina, there has been an interest in the utilization of local sawmill wood waste to produce electric energy.

The Cooperative has developed plans to build a 15MW wood-waste-fired-steam-electric-generating-plant in Burnsville, North Carolina, and has done a detailed feasibility study of this concept.

Unfortunately, at present, the state of the economy in the United States has seriously affected the operation of the mills and, until an assured supply of fuel can be made, the plans will not be followed through.

At North-Carolina Electric Membership Corporation (NCEMC) in Raleigh, North Carolina, there has been an interest in using local peat resources to fire a power plant (much as is presently being done in Finland, Iceland and Russia).

Considerable experimentation with harvesting technologies has been done and, together with NRECA and The Electric Power Research Institute of Palo Alto, California, a study was performed of the suitabilty of this concept.

The study, which has been released in draft form, found that the proposed site was the most desirable one (in terms of drying climate and peat quality) in the United States for such a plant and that the economics are competitive with a coal-fired plant of the same size.

Presently NCEMC is awaiting developments on their potential access to the peat resources in question before they proceed with additional developmental steps.

At Seminole Electric Cooperative in Tampa, Florida, there is a similar interest in peat-fired generation of electricity.

GEOTHERMAL ENERGY

Geothermal Energy has two main possible applications. One is for direct heat (heating, industrial process heat, etc.). The other is for electric power production. The determinant appears to be the temperature of the water available from the geothermal system. Temperatures below 290 F appear to have little use for anything but heating use. Above 290 F, electric power production starts to become feasible.

Hot Springs County Rural Electric Association in Thermopolis, Wyoming has been assisting the local town in evaluating the feasibility of using geothermal hot water 130 F for heating. At present, the concept is not economically competitive with natural gas, and there is some concern with reducing the discharge of the local hot spring.

Navopache Electric Cooperative in Lakeside, Arizona has for some time now been interested in the use of local hot dry rocks in high temperature gradient formations to generate electricity.

They have performed a study of the feasibility of this concept and found that it is, indeed, feasible. With 360 F temperature water (which they can obtain from a fracture system at 12,000 feet) they believe that they can sustain a 50MW power plant.

The National Rural Electric Cooperative Association in Washington, D.C. has been interested in Geothermal Energy and the potential value it might have to the people of Rural America for several years now. For the last 3 years the Association has acted as a conduit of resource information to its membership.

In addition, in November 1980, together with the U.S. Department of Energy, NRECA held a geothermal workshop for its members. Over 100 Rural Electric people attended the two days of briefings in San Diego, California and the one-day tour of geothermal facilities and power plants in the Imperial Valley.

Plains Electric Generation and Transmission Cooperative in Albuquerque, New Mexico became interested in efforts by Los Alamos National Laboratories to exploit Hot Dry Rock Geothermal Energy at the nearby Fenton Hill Site.

They applied for and obtained a grant from the U.S. Department of Energy to study the feasibility of this technology for the production of electrical power at this site on a utility scale.

They found that the Fenton Hill site is capable of producing 10 MW of electrical power on a sustained basis and that the only serious constraint is the replacement of water losses.

In 1980 Plumas Sierra Electric Cooperative in Portola, California joined Northern California Power Agency (an association of municipal power companies) and helped to finance a 110MW geothermal power plant at the "Geysers" dry steam field nearby.

The plant has been built and will be operating in early 1983. Plans are now being laid for a second and larger plant in the same area.

Raft River Rural Electric Cooperative in Malta, Idaho started back in the early 1970's to explore the value of local geothermal hot water. The Cooperative obtained a lease and put in a test well and found 290 F temperature water.

When the U.S. Energy Research and Development Authority was looking for a site to test the Binary Hydrothermal power plant concept they chose this site. Working together with the Cooperative they installed a 60kW unit and had good test results.

Later, when they became the Department of Energy, they decided to install a 3MW pilot power plant at the site. They dug more wells and built the plant.

During this process they ignored suggestions by the Cooperative.

The plant was completed in 1981 but has never run properly and is not capable of being operated as a generating facility. Now the Department of Energy is planning on dismantling it.

The Cooperative, which still has the lease on one of the wells to the plant, continues to be interested in using geothermal to generate electric energy and exploring that option.

A group of Electric Cooperatives in West Texas have joined together with the State of Texas and the University of Texas at El Paso to explore West Texas' Geothermal energy potential. Exploratory drilling in the area between the Rio Grande and the City of El Paso, where hot springs can be found, has produced some healthy geothermal gradients. The work is continuing.

SMALL HYDROELECTRIC[4]

The Rural Electric Systems are well-acquainted with hydropower. The backbone of the Federal power supply system upon which the Rural Electric Systems depend is hydroelectric.

In addition, during the 1950's, the Rural Electric Systems themselves owned and operated as many as 43 small hydroelectric generating plants.

During the 1960's and 1970's, as these plants became antiquated and expensive to operate, they were abandoned and fell into disrepair (as, of course, did many other similar facilities in the United States).

Today, the Rural Electric systems are very active in renovating these plants along with developing the hydro potential at many additional sites in their service territories.

Since the hydroelectric development process in the United States follows a process of permitting, licensing and finally plant construction and operation, let us discuss these many Rural Electric small hydro activities according to this logical sequence.

Projects Seeking Permits

The following Rural Electric Projects are in the process of seeking permit approval from the United States Federal Energy Regulatory Commission. As such, they have had preliminary feasibility analyses and were found to be good candidates for development.

Rural Electric System	Site	Capacity(MW)	Head(ft)
Big Rivers Elec. Mbrshp. Co. (KY)	Smithland	120.0	22
Central Montana G&T	Yellowtail Dam	12.0	50
Emerald People's Utility Dist. (Idaho)	Huckleberry Creek	1.1	1060
Fall River REC (ID)	Warm River	4.5	200
Kansas Electric Power Co-op	Glen Elder Dam	3.5	60
N.C. Electric Mbrship Co-op	Cape Fear #1	3.0	11
"	W. Kerr Scott	2.0	65
"	B. Everett Jordan	3.5	57
"	Cape Fear #2	3.0	9
"	William D. Huske	3.0	9
Oconto Electric P&L Co-op (WI)	Chute Pond	.2	14
Vermont Electric Co-op	Dewey's Mills	2.7	45

Permitted Projects

The following Projects have obtained site permits from the United States Federal Energy Regulatory Commission. They have a certain amount of time to do further study on the site (3 years) and see it they actually want to proceed with its development.

Rural Electric System	Project Name	Capac.(MW)	Head(ft)
Alabama Electric Co-op	Demopolis	30.0	35
"	Clairborne	15.0	22
"	Gainesville	15.0	35
Allegheny Elec. Co-op (PA)	Emsworth	20.0	10
"	Montgomery	20.0	18
Arkansas Electric Co-op	Irons Fork	0.3	60
Arkansas Valley Elec. Co-op	Toad Suck	25.0	14
Big Rivers El. Mbmr. Co.(KY)	Newburgh	60.0	16
"	Uniontown	75.0	18
Blachy-Lane Cty. El. Co.(OR)	Horn Power	3.5	40
"	Lake Creek	5.0	250
Cajun El. Power Co-op (LA)	Columbia	75.0	40
"	Jonesville	75.0	40
Colorado Ute Electric Assn.	Tri County	20.0	110
East Ky. Power Co-op	Grayson	2.0	45
Emerald P.U.D. (Oregon)	Black Creek	0.9	2200
Fall River Rural Elec. Co-op (ID)	Island Park	5.0	79
Kansas Elec. Power Co-op	Tuttle Creek	14.8	60
"	Perry Lake	58.0	80
"	Milford Lake	14.6	120
"	John Redmond	7.0	79
Kittitas County P.U.D. (WA)	Cle Elum	20.0	122
"	Easton	3.0	40
"	Kachess	3.2	59
"	Keechelus	4.4	68
"	Roza	6.0	30
Klickitat Cty. P.U.D. (WA)	White Salmon Rive	38.0	1300
Lost River REC (Idaho)	Canyon Lake	10.0	22
Mason County P.U.D. (WA)	Hamma Hamma 1	0.8	50
"	Washington Creek	0.6	155
"	Boulder Creek	3.0	1060
"	Hamma Hamma 2	0.9	100
"	Duckabush	35.0	300
"	Vance Creek	1.3	25
"	Rock Creek	1.8	355
Northeast Texas El. Co-op	Ferrell's Bridge	5.0	47
"	Wright Patman	8.0	51
Northern Wasco P.U.D. (WA)	White River	8.5	180
Oconto El. Co-op (WI)	Pulcifer	0.8	15

Permitted Projects (cont'd)

Rural Electric System	Project Name	Capac.(MW)	Head(ft)
Pacific Northwest Generating Co. (OR)	Arnold Flume	3.5	100
"	Columbia S. Canal	9.0	240
Surprise Valley REC (CA)	Ana Spring	0.35	50
"	Big Sage	1.5	350
"	Drews	0.4	45
Twin Valleys P.U.D. (NE)	Washoe	2.4	87
Washington Elec. Coop (VT)	Peak Shaver 1	0.2	12

Projects Seeking Licenses

The following Rural Electric Small Hydro projects are at the stage where the Rural Electric System is ready to commit their resources to construct a new plant or refurbish the old one. As such, they are seeking a license to construct and operate a plant on this site from the Federal Energy Regulatory Commission.

Most projects have gone through a very rigorous feasibility analysis before a license is applied for. Hundreds of thousands of dollars have been spent on the project by this point.

Rural Electric System	Site Name	Capacity	Head
Allegheny Elec. Co-op (PA)	Raystown	20.3	172
"	Allegheny L&D 8	13.0	14
"	Allegheny L&D 9	10.0	
Arkansas Elec. Co-op	Lock & Dam #2	120.0	45
"	Lock & Dam #3	48.0	18
"	Lock & Dam #4	27.0	
"	Lock & Dam #5	36.0	16
"	Lock & Dam #6	39.6	17
"	Lock & Dam #9	42.4	19
"	Lock & Dam #13	33.2	19
Blue Ridge Elec. Membership Co. (NC)	Sharp Falls	0.2	
Colorado Ute El. Assn.	Tacoma-Ames	1.4	
Middle Tennessee EMC	Walter Hill		
Northern Lights Elec. Co-op (ID)	Kootenai	178.6	78
Raft River REC (ID)	Eagle Rock	47.0	45

Licensed Projects

Small hydro projects that have reached this stage will probably be built. The Rural Electric System has already spent many tens or hundreds of thousands of dollars on the project and after lining up proper financing, construction will proceed.

Rural Electric System	Site Name	Capacity(MW)	Head(ft)
Broad River E.M.C. (S.C.)	Cherokee	3.5	15
Kamo Elec. Co-op (OK)	Kaw	30.0	60
Lost River El. Co-op (ID)	Mackay	3.0	54
Lower Valley P&L (WY)	Swift Creek	2.1	180

Projects Under Construction

These plants have their FERC licenses and are under construction at the moment. They should be operational within a year or two.

Rural Electric System	Site Name	Capac.(MW)	Head(ft)
French Broad EMC (NC)	Capitola	3.3	8
Kodiak Electric Assn. (AK)	Terror Lake	20.0	1150
Vermont Electric Co-op	N. Hartland	4.0	60

Operating Hydroplants

Finally, a number of Rural Electric Systems have small hydro plants which are operational. The following is a list of these plants.

Rural Electric System	Location	Capac.(MW)	Head(ft)
Alabama Electric Co-op	Andalusia, AL	5.2	40
Alabama Electric Co-op	Gantt, Al	2.4	25
Chugach Elec. Assn.	Cooper Landing, AK	15.0	736
Colorado Ute Elec. Assn.	Ames, CO	4.0	1015
Colorado Ute Elec. Assn.	Tacoma, CO	7.0	986
Colorado Ute Elec. Assn.	Ouray, Co	0.5	437
Copper Valley Elec. Assn.	Valdez, AL	12.0	620
Craig-Botetourt Elec. Co-op	New Castle, VA	.3	560
Dairyland Power Co-op	Ladysmith, WI	15.0	62
Fall River REC	Felt, ID	1.2	90
Garkane Power Assn.	Boulder, UT	5.2	1400
Lower Valley P & L	Bedford, WY	1.5	450
Metlakatla P & L	Metlakatla, AK	3.0	750
Moon Lake El. Assn.	Neola, UT	1.2	650
Moon Lake El. Assn.	Altamont, UT	0.9	229
Northern MI. El. Co-op	Tower, MI	.6	20
Northern MI. El. Co-op	Tower, MI	1.2	42
Oconto El. Co-op	Stiles, WI	1.0	19
Sho-Me Power Corp.	Camdenton, MO	3.0	40
Wells Rural El. Co-op	Well, NV	0.1	300

Let us look at some of these plants in more detail.

Alabama Electric Cooperative in Andalusia, Alabama serves half the state of Alabama and the panhandle area of Florida (through its member distribution cooperatives). The Cooperative has two small hydro plants. The larger, the "Point A" plant in Andalusia, Alabama, is a medium head plant (40 foot head). The

plant, which has been in operation for over 40 years now and has recently been refurbished, has 3 Francis turbine units in the powerhouse generating a total of 4.2 Megawatts.

The smaller one is the Gantt, or Conecuh River Plant. This is under reconstruction (as mentioned above).

Colorado Ute Electric Association in Montrose, Colorado serves nearly half of the state of Colorado through its member distribution cooperatives. They have 3 small hydro plants: Ames, Tacoma and Ouray.

The Ames plant has great historical significance. It was the plant which brought electrical power to Telluride and made it one of the first towns in the country to have incandescent lighting. It was also the first AC generating facility in the world. Today, after 90 years, the plant is still operating and providing 4 megawatts through its Pelton wheel turbine/generator unit to local consumers.

The Tacoma Plant, located near Durango, Colorado has an installed capacity of 7 megawatts from its three Pelton wheel turbine/generator units. The dam has been replaced and an additional turbine/generator unit will be installed to increase capacity to 15 megawatts.

The Ouray plant, located near Ouray, Colorado, is an older plant of 500kW capacity, built in 1902. The plant was damaged by lightening in 1974. The generator was rebuilt in 1982 and the plant is now back in service. It is located on the Uncompahgre River with a dam, a penstock running 6200 hundred feet downstream, and a single 500kW Pelton wheel turbine-generator-unit in the power house.

Copper Valley Electric Association, Valdez, Alaska (where the Alaska Pipeline reaches the sea) initially conceived of the idea of tapping the hydro potential between Solomon Lake and the sea in the mid 1970's. The Coop borrowed the money to do the job in 1978 from REA. A 115 foot high earth-filled dam was constructed and two 48" diameter steel penstocks run down along Solomon Gulch 4159 feet to the plant located on the coast. Total vertical drop is 620 feet.

Craig Botetourt Electric Cooperative located in New Castle, Virginia has a high head, smallhydro electric plant.

The plant is located on Meadow Creek near the town of Looney, Virginia.

The stream is diverted through a diversion dam, and the water flows through a penstock down the hill to the plant (which has a Pelton wheel turbine and a 300kW generator).

The plant has been operating since 1938, and the co-op plans to refurbish it and continue to operate it.

Dairyland River Cooperative in Lacrosse, Wisconsin serves half of the state of Wisconsin and portions of Minnesota, Iowa and Illinois through its member distribution systems. Thirty years ago they built a hydroelectric plant on the Flambeau River near Ladysmith, Wisconsin. This plant (the Flambeau Plant) is a medium head plant (62 foot head) with a dam with earth/concrete construction. The power house has 3 Vertical Axis (S. Morgan Smith) Kaplan reaction-turbine-generator units (5 megawatts each) producing a total of 15 megawatts of power.

Fall River Electric Cooperative, with its headquarters in Ashton, Idaho, has a 1.2 megawatt small hydroelectric plant which they recently rebuilt.

The plant is on the Teton River near the town of Felt, Idaho. A dam has been constructed about 1/4 of a mile upstream. The water is diverted via this dam to two penstocks, which run down the hill to a plant containing two 600 kW Leffel turbine generator units. The power, generated at 2,500 volts, is taken from the plant, stepped up to 44,000 volts through a special substation and utilized in the co-op's distribution system.

Garkane Power Association in Richfield, Utah has a high head small hydro plant which was placed on line in 1958. This plant (the "Boulder" plant) has a diversion dam and penstock (which runs five miles down to the power house). The power house contains 3 x 1.75 MW (Elliott) horizontal-axis-Pelton-wheel-turbine-generator-units for a total plant capacity of 5.2 megawatts.

Lower Valley Power and Light, located in Afton, Wyoming, has a 1.5 megawatt hydro plant on the Strawberry Creek. The plant (which has recently been recommissioned) has a dam where the water is diverted into a 6 foot diameter penstock which runs three miles along the streambed to a set of three 500kW Pelton wheel turbine units located in the power house at the mouth of the canyon. The energy, produced at 2,400 volts, is stepped up to 7,200 volts for distribution to their consumers.

Moon Lake Electric Association in Roosevelt, Utah, has two high head small hydro plants operating.

The "Uintah" plant, located near the town of Neola, Utah, with a capacity of 1.2 megawatts, has a diversion structure on the Uintah River and two penstocks which run one mile downhill to a power house containing two horizontal axis Pelton wheel turbine generator units with a capacity of 600 kW each.

The "Yellowstone" plant near Altamont, Utah takes water from a dam on the Yellowstone River through a penstock which runs three miles downhill to a single 900kW Leffel impulse-turbine-generator-unit in the power house. Power is stepped up at the

switchyard to transmit to consumers on the Moon Lake system.

Oconto Electric Cooperative, in Oconto Falls, Wisconsin, has a low head, small hydro plant (the "Stiles" plant) on the Oconto River. The plant has two vertical axis, Allis-Chalmers turbine-generator-units in the power house, each supplying 500 kW (for a total of one megawatt of electrical power), which they use for peaking purposes on their system.

Wells Rural Electric Company, in Wells, Nevada, has a high head plant which has been operating for 50 years and which they have recently rebuilt. The plant has a diversion structure at a spring in Trout Creek, near the town of Wells. A penstock carries the water 1 and 1/2 miles downhill to a powerhouse where a Pelton wheel turbine-generator unit generates 120 kW of power on a continuous basis.

Small Hydro Programs

In addition to these activities, some special coordinated efforts within the Rural Electric Community should be noted.

The Alaska Power Authority, an agency of the state of Alaska (set up to ensure the electric energy supply of the state of Alaska), utilizing revenues from oil production on the North Slope, is engaged in a coordinated effort across the state to develop small hydroelectric potential.

Some of these projects which involve Rural Electric Systems and provide for their power supply (in addition to the Copper Valley Electric Association/Solomon Gulch plant already discussed under the sections on operating and constructing R.E. small hydro plants) are:

Rural Electric System	Site Name	Capacity(MW)
Cordova Electric Co-op	Silver Lake	15
Golden Valley Elec. Assn.	Susitna	1020
Homer Electric Assn.	Bradley Lake	135
Metlakatla P & L	Chester Lake	2.5
Tlingit-Haida R.E.A.	Black Bear Lake	6.0

Also, the Arkansas Electric Cooperative Corporation, in Little Rock Arkansas, (a generation and transmission cooperative responsible for the power supply to all of the Rural Electric Systems in the state of Arkansas) conceived of the idea of harnessing the unused hydroelectric potential of the Arkansas River by installing generating units on the lock and dams along it in the late 1970's.

They have perservered with this concept and its development to the point where they are in possession of permits for or are applying for the licenses for hydroelectric construction for as lock and dam Nos. 2, 3, 4, 5, 6, 9 and 13 (with total estimated electric generating potential of 346.2 Megawatts).

The Rural Electrification Administration, through its Energy Management and Utilization Division (in operation from 1979-1982) managed to assist many Rural Electric Systems to evaluate their hydroelectric projects, work through the maze of federal paperwork in applying for and obtaining the appropriate permits and licenses, and obtain loans for feasibility studies and construction of these projects. Before the Reagan Administration abolished the program, they were a guiding light for Rural Electric Systems considering small hydroelectric projects.

The following is a list of loans made for small hydro feasibility analyses.

Rural Electric System	Site Name	Amount
Alabama Elec. Co-op	Aliceville	$343,000
"	Claiborne	400,000
"	Coffeeville	344,000
"	Demopolis	385,000
"	Gainesville	344,000
"	Gantt	250,000
"	Warrior	344,000
Arkansas Elec. Co-op	Arkansas Pwr. L&D 2	40,000
"	Arkansas Pwr. L&D 3	40,000
"	Arkansas Pwr. L&D 4	40,000
"	Arkansas Pwr. L&D 5	40,000
"	Arkansas Pwr. L&D 6	40,000
"	Arkansas Pwr. L&D 9	40,000
"	Arkansas Pwr. L&D 13	40,000
"	W. D. Mayo Dam	55,000
Allegheny Elec. Co-op	Raystown Dam	500,000
"	Emsworth Dam	232,000
Broad River Elec. Co-op	Cherokee Falls	48,000
Cajun Elec. Power Co-op	Caddo Lake	25,000
"	Columbia	25,000
"	Jonesville	25,000
"	Lake D'Arbonne	25,000
Fall River Elec. Co-op	Felt Dam	46,000
"	Island Park	130,000
French Broad AMC	Capitola	735,000
Kamo Electric Co-op	Kaw	55,000
Kodiak Electric Co-op	Port Lyons	107,000
Mason County P.U.D.	Duckabush	50,000
"	Hamma Hamma	50,000
Pacific NW Generating Co.	Arnold Flume	30,000
"	Bend Canal	30,000
"	Columbia South Canal	40,000
"	North Unit Canal	30,000
"	Prineville	30,000
"	Savage Rapids	30,000
Raft River R.E.C.	Eagle Rock	924,000
Vermont Electric Co-op	North Hartland	500,000

In addition, the program was also responsible for a number of construction loans. A list of these loans follows.

Rural Electric System	Site Name	Amount
Alabama Electric Co-op	Conecuh River (Gantt)	$ 4,000,000
French Broad EMC	Capitola	7,000,000
Lower Valley P&L	Swift Creek	5,114,000
Vermont Electric Co-op	North Hartland	13,400,000

Finally, the National Rural Electric Cooperative Association has an International Programs Division which is celebrating its 20th year this year of helping to bring electric service to the rural areas of the underdeveloped world.

In May of 1980 they signed a contract with the U.S. Agency for International Development (AID) to develop the expertise in the area of small hydroelectric energy to assist the underdeveloped countries in evaluating and developing their potential resources.

The contract is to last 5 years and its main objective is to develop the capability within NRECA to provide technical, resource and site evaluation and project assistance in the field to underdeveloped countries and to act as an access point for small hydro information.

The program (The Small Decentralized Hydroelectric Program) responds to requests from AID Missions and, in a few cases, from underveloped countries.

To date, the program has had 20 field assignments in developing countries (doing resource surveys, providing design assistance and performing site evaluations). It has also assisted AID in setting up programs to engage in major small hydro development on a country-by-country basis.

A library has been set up in Washington, D.C. which responds to an average of 10 requests per week for information.

A number of regional small hydroelectric workshops have been held where interested persons from the underdeveloped countries can attend and acquire knowledge and information on small hydro. These workshops were held in:

Quito, Ecuador in August 1980
Bankok, Thailand in June 1981
Abjin, Ivory Coast in March 1981

and another one is scheduled in

Mbabane, Swaziland in early 1983.

NRECA is proud of the effort of this team of dedicated individuals to assist the third world in developing their hydroelectric potential.

SOLAR ENERGY

The Solar Projects at Rural Electric Systems can be divided up into two main categories: those that have to do with solar heating (and direct use of solar energy) and those that have to do with the conversion of solar energy to electrical energy.

Solar electric projects can, in turn, be divided up into the subcategories of Solar Thermal Electric and Photovoltaics, although it is not really necessary in this treatment because the list is not lengthy.

Solar Heating Projects

The solar heating projects at Rural Electric Systems which are of most interest are the ones where the Rural Electric Systems have installed solar heating on their own property and/or where they have monitored the performance of a solar heating system.

Basin Electric Power Cooperative in Bismarck, North Dakota, the largest Rural Electric System in the United States, in 1978 installed a 5,000 square foot solar collector system which provides active heating supplement for their headquarters building in Bismark at a cost of $400,000. The system has been operating successfully for 4 years now. It is providing from 10-15% of the building's heating energy needs.

Cooperative Power Association in Eden Prairie, Minnesota (responsible for the power supply for the Rural Electric Systems in southeastern Minnesota) has built passive solar features into their new ultramodern headquarters building. The building is designed to be energy efficient, and utilizes an earth berm to shelter it from the north side.

In 1979, The Cotton Electric Cooperative in Walters, Okalhoma installed a supplementary solar hot water heating system on the roof of their headquarters building. It is still operating.

In 1973, East River Electric Cooperative (with its headquarters in Madison, South Dakota, and serving the eastern portion of the state of South Dakota) decided to investigate the use of solar energy for the drying of crops. Together with a local university, they built several solar crop dryer installations onto existing grain bins and experimented with the effectiveness of them to dry the crops in those bins. The results were made available to local farmers who have built a number of similarly designed installations.

Middle Tennessee Electric Membership Corporation in Murfreesboro, Tennessee was chosen by the Tennessee Valley Authority (TVA) to be the site of a solar heating demonstration program. Through TVA, Middle Tennessee is financing solar water heater installations. To date they have financed and installed 500 such systems on their service territory.

Mountain View Electric Association in Limon, Colorado has just completed construction on a new operations facility (near Colorado Springs) which incorporates active and passive solar heating features.

The National Rural Electric Cooperative Association in Washington, D.C. installed a solar hot water heating system on its new headquarters building in 1979. The system is supplementing electric hot water heating requirements.

San Luis Valley Rural Electric Cooperative in Monte Vista, Colorado has several solar projects underway.

One of them is the use of a forced air solar heater on their garage at their headquarters location.

The other project is the financing and testing of a solar house heating installation at a local subdivision.

Sulphur Springs Valley Rural Electric Cooperative in Willcox, Arizona has had an interest in solar energy for heating purposes for some time now. The Co-op has purchased and is testing both a flat plate and a concentrator solar hot water heating system on the roof of its Sierra Vista operations office.

Swisher Electric Cooperative in Tulia, Texas also has a solar hot water heating system on the roof of its headquarters building. The Co-op started out with a concentrator system and is now using a flat plate collector system.

United Electric Cooperative in DuBois, Pennsylvania has a solar hot water heater/heat-pump heater-augmentation-solar-system on the roof of its headquarters building. The system has been performing well for several years now.

United Power Association of Elk River, Minnesota is planning on installing a solar hot water heating system on their headquarters building in 1983. In addition, they are (together with Wright Hennepin Co-Op Electric Association of Maple Lake, Minnesota, one of their member distribution systems), monitoring the performance of a unique solar house heating system in that co-op's service area which operates in tandem with a heat storage system built into the floor of the house.

Verendrye Electric Cooperative in Velva, North Dakota, has installed a solar hot water heater on the roof of its headquarters building. This hot water heater provides hot water for its offices and performance and cost data for its members who are interested.

The Wyoming Rural Electric Association in Casper, Wyoming recently built a new headquarters building. They were awarded a grant from the U.S. Department of Energy to install a solar space heating system into the design. The system, which has been operating since 1977, has operated well since them.

Solar Monitoring Projects

In addition to those mentioned above, the following Rural Electric Systems represent a few of those who have been monitoring one or more local solar heating/hot water installations to determine the impact of this system on electric energy consumption by the household involved. They are making this information available to interested consumers, as well as using it for planning purposes. They are:

Carroll Electric Membership Corp., Carrollton, Georgia
Douglas County Elec. Membership Corp., Douglasville, GA.
Eastern Iowa Light & Power Co-op, Wilton, Iowa
East River Electric Power Cooperative, Madison, S. Dakota
H-D Electric Cooperative, Clear Lake, South Dakota
Kit Carson Electric Cooperative, Taos, New Mexico
Steele-Waseca Cooperative Electric, Owatonna, Minnesota

Solar Electric Projects

The Rural Electric Systems are also involved with the utilization of solar energy to produce electric power.

Arizona Electric Power Cooperative of Benson, Arizona and Brazos Electric Power Cooperative of Waco, Texas are part of the utility advisory council to the project to install (in a repowering mode) 40 Megawatts of Solar Thermal Electric Power at the Newmann oil-fired generating station outside of El Paso, Texas (El Paso Electric Company).

Colorado Ute Electric Association of Montrose, Colorado, along with a group of other western utilities (West Associates), is a member of the Advisory Committee for the 10MW Solar Thermal Power plant in Barstow, California, which just recently commenced operations. The advisory committee provides guidance to the project and reviews the project programs on a quarterly basis.

Corn Belt Power Cooperative of Humboldt, Iowa, which has for several years now been testing new forms of energy on an experimental farm (belonging to Land O'Lakes Corporation) is interested in trying a farm-sized photovoltaics application.

Lea County Electric Cooperative in Lovington, New Mexico, was the recipient of a grant (from the U.S. Department of Energy in 1979) to build an "intermediate" sized photovoltaic electric power production facility. The plant, which has an output of 100kW, is located adjacent to a shopping center in Lovington. It is designed to supply power to the shopping center and other nearby installations through Lea County's lines.

The array, (which consists of flat plate silicon cell modules, manufactured by Solar Power Corporation [a subsidiary of Exxon]) covers approximately 1 acre. The cost of the project was approximately $3 million. Measurements and testing are continuing.

Papago Tribal Utility Authority in Sells, Arizona has been participating in the demonstration of photovoltaic technology for several years now. The village of Schuchuli is the site of a 3.5kW photovoltaics array, which is supplying electricity (for lighting, laundry, refrigeration and other uses) in a place where there is no central station electric service. The project was financed by the U.S. Department of Energy.

Plains Electric G&T Cooperative of Albuquerque, New Mexico is one of the participant utilities in the Electric Power Research Institute's 1 MW electric power plant operations simulation experiment at the Solar Thermal Test Facility in Albuquerque, New Mexico. EPRI plans to install a 1 megawatt solar power plant at the facility and give utility personnel a chance to acquire operational experience.

Solar Informational Services

Finally, many Rural Electric Systems (either through their regular publications and meetings, or using special publications and/or meetings) have tried to inform their membership on the use of solar energy.

A few examples of this activity are:

"Solar Water Heating", a special report by Adams Rural Electric Cooperative of Gettysburg, Pennsylvania.

"Sun Spots", a regular column in "Arizona Currents", the regular publication of Grand Canyon State Electric Co-op in Phoenix, Arizona.

A special report on conservation and solar energy by Intermountain Rural Electric Association of Sedalia, Colorado.

A series of special articles in the Co-op Newsletter by Nodak Rural Electric Cooperatives of Grand Forks, North Dakota.

A special brochure on solar passive heating by Lumbee River Electric Membership Corporation of Red Springs, North Carolina.

A series of solar workshops by Sand Mountain Electric Co-operative in Rainsville, Alabama.

A series of special articles in the Co-op newsletter by Valley Rural Electric Cooperative in Huntington, Pennsylvania.

SYNFUELS

For the purposes of this paper, synfuels includes:

Coal Liquification

Coal Gasification

Tar Sands

Oil Shale

Rural Electric Systems have a relatively small involvement in synfuels at the moment. Synfuels projects are enormously expensive, because they are only sensible on an enormous scale. For this reason only the large power supply or "Generation and Transmission" cooperatives have been involved.

The following is a brief description of Rural Electric Systems' involvement with synfuels.

Allegheny Electric Cooperative in Harrisburg, Pennsylvania (the power supply organization for the Pennsylvania and New Jersey Rural Electric Systems) became interested in 1979 in the concept of using methane underground coal-mining operations, abandoned mines and unmineable coal seams to fuel converted diesel generators in their service territory. They are still interested in the concept and have done some preliminary work with Westinghouse Research Center in Pittsburgh on a possible demonstration project.

Basin Electric G&T Cooperative in Bismark, North Dakota, the power supply organization for the rural electric systems in 8 central/western states, has built its two newest power plants (the Antelope Valley plants) on the same site as the "Great Plains Coal Gasification Project."

Basin is providing the project with electrical energy and the two facilities are sharing the same fuel storage and handling facilities.

By doing this, both projects improved the economics of their own and the other's endeavors.

Associated Electric Cooperative, with its headquarters in Springfield, Missouri (the power supply organization for Rural Electric Systems in all of Missouri and part of Iowa), together with a local organization, the Consumer Energy Corporation, conceived of the idea, in 1979, of building a coal gasification combined cycle power plant, together with a methanol synthesis plant, in Cameron, Missouri. The idea was to create local jobs and to utilize Missouri's substantial deposits of high sulfur soft coal (which cannot be used in a straight combustion process with today's sulfurdioxide emission standards). Although the project never received funding from the U.S. D.O.E./U.S. Synfuels Corporation programs, the Co-op is still interested in the concept.

East Kentucky Power Cooperative, with its headquarters in Winchester, Kentucky (the organization responsible for the power supply of the Rural Electric Systems in the eastern half of the state of Kentucky) has recently shown an interest in the extraction of oil from local Kentucky oil shale.

The Cooperative is going to study the feasibility of moving the Parachute Oil Shale Plant in Colorado (a pilot unit) to one of the properties they own near Trapp, Kentucky.

WIND ENERGY

Wind energy and its use is no new thing to the people of Rural America. In the beginning of this century, there were hundreds of thousands of wind machines in use across the United States. Most of them were used for pumping water, but some of the more well-to-do farmers used wind for charging batteries to run the radio and refrigerator. In some cases, wind machines (Aeromotor, Wind Charger, Jacobs, etc.) were the principal source of electrical energy for the farm. Then the Rural Electrification program came along in the 1930's, 1940's, and 1950's and brought central station electricity to people in Rural America at an affordable price.

Wind electric generation almost ceased to exist in Rural America. However, it is now coming back! Because of the advances that have been made in wind turbine technology and the rapidly increasing costs of fuels, generating plants, and wholesale electricity, wind turbine generators are once again appearing across the countryside. The management and membership at rural electric systems are investigating this technology seriously.

Let us look at some of the efforts of the Rural Electric Systems to: evaluate local Wind resources, monitor the performance of wind machines, and ascertain the potential of Wind Energy to meet future electric demand.

In the interests of organizational clarity, let us divide the wind projects of Rural Electric Systems into the following subcategories:

- Large Wind Machines
- Small Wind Machines and Wind Machine performance monitoring
- Wind Resource Evaluation
- Wind Information Services

Large Wind Machines[5]

Those Rural Electric Systems that are involved with or are investigating large wind machines have the idea in mind of someday generating electrical energy on a traditional utility scale for the purpose of helping them to meet demand.

Let us look at some of these projects.

Blue Ridge Electric Membership Corporation (BREMCO) of Lenoir, North Carolina was selected in 1977 as the site for the installation of the first Megawatt-sized wind turbine to be built by the U.S. Department of Energy. The 2.0 Megawatt wind turbine was constructed and completed in 1979 on the top of a hill overlooking the town of Boone, North Carolina in their service area. Although DOE has recently decided to dismantle the machine and move it to another location, BREMCO has acquired a great deal of firsthand experience with the operations and maintenance of a utility scale wind generator through this project.

Coos-Curry Electric Cooperative of Coquille, Oregon contributed funds for the 500 kW ALCOA vertical axis wind turbine jointly purchased by a consortium of Oregon Cooperatives, Municipals and PUDs. The machine has been dismantled and removed because of ALCOA's decision to go out of the wind turbine business. However, they still have a nationally ranked large wind turbine site in their service area that they are monitoring the wind resources at.

East River Electric Power Cooperative in Madison, South Dakota has a serious interest in the potential of wind energy to generate power on a utility scale.

Along with the site at Boone, North Carolina (at Blue Ridge EMC) their site near Huron, South Dakota was selected in 1977 for possible installation of a large machine. They have monitored the wind resource at this site continuously since then.

They have applied for and received loans from the U.S. Rural Electrification Administration (totaling $1.4 million) to do a detailed feasibility analysis and site acquisition for a possible "wind farm" (12 x 2.5MW units). They are engaged in the determination of the feasibility of this project and are negotiating with the Western Area Power Administration and Boeing Engineering Company to be partners in this project.

Intermountain Consumer Power in Sandy, Utah had a site at Bridge Butte, Wyoming chosen by DOE as a candidate site for a future wind turbine experiment. DOE erected a meteorological tower to collect data. Intermountain Consumer Power has been monitoring the site since October 1981. Initial results show a high favorability for a 2000kW+ generation site. Monitoring will be necessary for 6-12 months to confirm this conclusion.

Klickitat County Public Utility District in Goldendale, Washington, together with Bonneville Power Administration, was selected as the site for the 3, MOD 2, 7.5MW wind turbine cluster, which was installed by the U.S. Department of Energy in 1982. The machines have experienced considerable startup difficulties. When fully operational, tests will be made of electrical performance and wake interaction, amongst other things. Klickitat, while not a major partner in the project, is gaining considerable exposure to large wind turbines by having the project in its backyard. In addition, in cooperation with Bonneville Power Administration and the University of Oregon, they have helped to install and monitor the performance of a number of 4kW Enertec wind generators at various forms in their service territories.

Naknek Electric Association, Naknek, Alaska is planning a a wind farm with Flo Wind Corporation of Washington. The plan is to install one 100kW vertical axis wind turbine (with the assistance of the Alaskan Power Authority) and, if things go well, install more later.

United Power Association of Elk River, Minnesota has a number of wind energy activities going on. UPA has purchased 15 sets of digital-wind-data-recorder-kits and will be lending them to member cooperatives in their service area.

They are also monitoring the electrical output performance of a Jacobs 10kW wind generator and a 1.8kW Enertec machine at East Central Electric Cooperative -- one of their member distribution cooperatives.

In addition, they have applied for a loan from the U.S. Rural Electriciation Administration (REA) for $90,000 to do a feasibility study of the use of wind energy to meet their peaking requirements (20-50MW) in 1990. The loan was approved in September 1981 and the work is underway.

Finally, they have done some rigorous analysis of the technical problems associated with the interconnection of wind generators on their system and published their findings.

Verendrye Electric Cooperative in Velva, North Dakota was chosen as one of the candidate sites for the MOD 2 wind turbine program by the U.S. Department of Energy in 1980. A wind monitoring tower was constructed at the site in Minot and wind measurements (at MOD2 hub and tip heights) are being taken. The U.S. Department of Energy considers this site, the one at Wells Rural Electric Cooperative in Nevada and the one at Coos-Curry Electric Cooperative in Oregon to be among the most promising for large wind turbine installations.

In addition, the Cooperative is assisting a member-consumer in a project where a homebuilt wind generator is being used to heat the member's home. This application is one that makes sense for an area where winds peak at the same time as winter heating load.

Wells Rural Electric Cooperative in Wells, Nevada, like Coos-Curry Electric Cooperative in Oregon and Verendrye Electric Cooperative in South Dakota, has a site which was chosen by the U.S. Department of Energy in 1980 as one of the optimal sites in the United States for large wind turbines. They have received a wind measuring tower from the Department of Energy and are continuing to measure the resource at the site at present.

The Co-op is also participating with Bonneville Power Administration in their wind monitoring program (using strip chart recorders and wind run recorders at several sites in their service territory).

Small Wind Machines[6] and Wind Machine Performance Monitoring

In the interests of having firsthand data and experience and of properly informing their consumers, many Rural Electric Systems have installed and/or are monitoring small wind generators.

Let us look at a few of these projects:

Baldwin County EMC, in Summerdale, Alabama is assisting a private consumer in monitoring the consumer's 2.1kW wind machine. The machine is interconnected with the Cooperative's system, and special metering equipment has been installed. Monitoring is on-going but the consumer is experiencing a severe voltage drop from the generator to the inverter. Large wire purchased from the Cooperative is presently being installed.

Central New Mexico Electric Cooperative, in Mountainair, New Mexico is monitoring an experimental 25kW wind turbine installed by Sandia Laboratories. The turbine, which powers an irrigation system, is interconnected to the utility system, and the utility buys excess power. Monitoring is complete.

Corn Belt Power Cooperative in Humboldt, Iowa has purchased an Enertec 4kW wind generator and installed it at an experimental farm owned and operated by Land O' Lakes Corporation. The machine, (which had to be rebuilt several times), is fully metered and is being tested for harmonics output, power factor, voltage fluctuation and total energy production.

Lea County Electric Cooperative of Lovington, New Mexico has purchased and installed a 25kW Carter wind generator (at their photovoltaics experimental test site) near a shopping center in Lovington. The machine has been operating since August 1981, and has performed well.

Also, they have taken measurements of wind velocity at the radio tower at their headquarters building for several years now.

Michigan Electric Cooperative Association in Lansing Michigan has been supporting (along with NRECA) the efforts of Professor Gerald Park at Michigan State University in his measurements of the quality and quantity of power output of wind machines. The experiment originally commenced with 2 wind machines at Dr. Park's test site at Michigan State University and has expanded to measuring the output of 25 different machines operating around the state of Michigan. Dr. Park intends to provide both a methodology for measuring the output of these devices and individual electrical performance data which can be used for machine evaluations in other locations.

Minnkota Power Cooperative of Grand Forks, North Dakota has an employee who has been involved in wind energy for several years now. Using his own money and machine shop, the Superintendent of the Engineering Department, LeRoy Sletten, built a 30kW windmill out of scrap metal. The machine has been up and operating for 3 years now.

South Crawford Rural Electric Cooperative in Dennison, Iowa purchased, installed and fully instrumented a Storm King 18kW wind generator at their headquarters to see if it was a feasible source of energy for member-consumers. The whole assembly collapsed in January 1982 and is being written off as a total loss.

Southern Iowa Electric Cooperative in Bloomfield, Iowa co-sponsored with the U.S. Department of Energy and the U.S. Department of Agriculture at the Co-op Manager's home a demonstration of the use of wind energy to heat a house. A 25kW Grumman wind generator was installed in 1979 and has been used for the last several years to heat the home in the winter and charge electric lawn mower batteries in the summer. The experiment appears to have been a considerable success.

This concept of utilizing wind energy (in areas where its maximum coincides with peak demand) in a local management mode has a great deal of appeal to Rural Electric Systems.

Southwest Central Rural Electric Cooperative in Indiana, Pennsylvania, together with NRECA and Allegheny Electric Cooperative of Harrisburg, Pennsylvania, purchased and installed an 8kW ALCOA vertical axis (eggbeater) wind turbine (with a complete wind and electrical energy monitoring package). The wind generator has never worked properly. It was erected in 1980 and was torn down after 2-1/2 years of attempting to make it function

properly. No data on performance was obtained. ALCOA has discontinued manufacturing this machine.

Somerset Rural Electric Cooperative in Somerset, Pennsylvania installed and has operated a 1.2kW KEDCO wind generator at a member-consumer's home in their service territory for approximately 6 months. They are measuring the energy production of this machine and will provide this information to other member-consumers interested in making a similar installation.

Unalakleet Valley Electric Cooperative in Unalakleet, Alaska is the site of a wind farm project financed by the state of Alaska's Department of Commerce and Economic Development. The project, which consists of an array of Jacobs 10kW wind generators near the town, is being financed by state legislature appropriation. So far, three machines have been installed.

United Electric Cooperative of DuBois, Pennsylvania financed the construction of a 10kW wind generator on cooperatively owned property at the house of a cooperative employee. They were intending to monitor the performance; however, the machine is still not operational. The company has now offered to remove it from the Co-op's property, because it cannot be made to function properly.

Victory Electric Cooperative in Dodge City, Kansas was chosen in 1979 by the U.S. Department of Energy to be the site for one of their small wind generators. The machine, a 2kW Pinson Cycloturbine, was installed in 1979. Serious problems were experienced with the electrical system, and in 1981 the tower was pronounced unsafe (a similar one having recently collapsed) and the machine was removed. Monthly energy prediction figures measured by the Cooperative (during the machine's operational periods) were on the order of 20kWh/month.

Washington Island Electric Cooperative on Washington Island, Wisconsin is testing the electrical performance of a 9kW Windworks wind generator (installed by the U.S. Department of Energy in August of 1981, on the Co-op's property). The machine has experienced considerable downtime since its installation last summer because of a tendency to go into overspeed.

White County Rural Electric Membership Cooperative in Monticello, Indiana equipped a wind turbine with three magnetic tape meters to monitor the energy output (which is led through an ac current control into the utility power pool). The three-blade wind turbine has a 4kW rating and is located on a 40 ft. tower. The generator begins to produce electricity in winds of 7-8 mph, reaching a peak capacity at 22-23 mph. The generator came on-line in late June 1980, after being out of service for a year. Monitoring is ongoing.

Wind Resource Evaluation

Many Rural Electric Systems, either because there is poor local wind data (and they would like to know what the local wind resource is) or because they have been given the opportunity to do so, are collecting wind data at one or more spots in their service territories.

Let us look at some of these projects.

Adams Rural Electric Cooperative of Gettysburg, Pennsylvania originally intended to purchase and install an 8kW vertical axis wind turbine from ALCOA (together with NRECA and Allegheny Electric Cooperative of Harrisburg, Pennsylvania). However, based on the performance of an identical machine at Southwest Central Electric Cooperative in Indiana, Pennsylvania (see description below), they postponed that decision and installed wind monitoring equipment to measure the resource at the site instead.

Bridger Valley Electric Association of Mountain View, Wyoming has purchased a wind instrumented tower from the U.S. Department of Energy and is continuing to take measurements at several heights. Data is being sent to Battelle Northwest Laboratories, where it is being fed into the ongoing national wind resource assessment effort there.

Matanuska Electric Association of Palmer, Alaska has received two sets of digital wind recording equipment from the state of Alaska. It will be measuring average wind speeds at different locations in their service territory for the next few years.

They also have a relatively large number (see Appendix A of this paper) of privately owned, interconnected wind generators at their member-consumer's homes. They are measuring and observing the performance of these machines.

Norton-Decatur Electric Cooperative in Norton, Kansas has a magnetic tape recording system recording wind velocity and electrical energy production (demand and kWh) on a Millville 10kW wind generator installed at a member-consumer's house. They also have a wind monitoring station at a location outside of town. They intend to determine whether the wind resource is sufficient to make wind generation economically feasible for their service area.

Seward County Rural Public Power District in Seward, Nebraska, along with some 19 other Rural Electric Systems in Nebraska has wind monitoring equipment (supplied through Western Area Power Administration (WAPA) and the state of Nebraska).

They are taking wind measurements and recording them on magnetic tapes which are translated at WAPA's Denver office.

Sheyenne Valley Electric Cooperative in Finley, North Dakota has a site at Finley AFB, ND that was chosen by DOE as a candidate site for a future wind turbine experiment. DOE will erect a meteorological tower to collect data; Sheyenne Valley will monitor the site. The project was initiated in October 1981. Data are presently being collected.

They are also monitoring demand and energy output from an Enertec 4kW wind generator at a member-consumer's home.

Tri-State G&T Association of Denver, Colorado has purchased wind monitoring equipment and is measuring wind resources at 4 locations in their service territory. In addition, they will soon be running a much larger wind resource assessment program with Western Area Power Administration (WAPA) where they will put out a number of inexpensive instrument packages to measure wind resources. Tri-State is a very progressive electric utility with a great deal of interest in wind energy.

Vermont Electric Cooperative in Johnson, Vermont received a grant from the U.S. Department of Energy to purchase and install wind measuring equipment. The measurements are being taken at the ski resort at Mt. Snow. The equipment has experienced tremendous icing problems (2 feet diameter ice buildup on a 5/16" guy cable). Measurements are recorded on mag tapes being sent to Battelle Northwest Labs for analysis.

Vigilante Electric Cooperative in Dillon, Montana has received an anemometer/recorder wind prospecting package from Bonneville Power Administration (BPA) and will be measuring wind at a site near Whitehall, Montana for a number of years as part of the area-wide BPA wind resource measurement program. A number of other rural electric cooperatives (15) in the BPA area are also participating in this program.

Wind Information Services

Finally, a number of Rural Electric Systems, feeling it their duty to properly inform their membership on the pros and cons of wind energy, have produced publications, slideshows on wind energy and workshops as public information services.

A sample of some of these activities follows.

Butler Rural Electric Cooperative of Hamilton, Ohio has prepared a wind energy slide show and briefing document which they have shared with their consumers at several meetings. The shared documents are an excellent introduction to wind energy and its potential.

The National Rural Electric Cooperative Association of Washington, D.C. has considerable involvement with wind energy.

The Energy Research Division at the Association has for years been closely following the developments of the wind industry and advising its member cooperatives of these developments. A highly emphasized area of concentration has been the technical and liability concerns connected with interconnection of privately-owned wind generators to rural electric lines. (See Appendix B of this paper.)

NRECA has also supported a number of projects related to wind energy usage during the last several years (including the wind monitoring at Adams Electric Cooperative, the wind generator at Southwest Central Electric Cooperative, and the work at Michigan Electric Cooperative Association).

And, finally, in the summer of 1980, NRECA and the U.S. Department of Energy sponsored a wind energy workshop for Rural Electric Systems. Over 100 Rural Electric employees attended the two days of technical briefings and the tour of the Medicine Bos, Wyoming large wind turbine site.

Union Rural Electric Association in Brighton, Colorado has, since 1978, been studying the impacts of wind generators on rural electric distribution systems. They published a report in conjunction with the U.S. Department of Energy on the subject in 1980. In 1981, they held three wind energy workshops for member-consumers and put together an excellent slide presentation (together with TriState G&T Coop in Denver) to brief prospective wind machine owners. The Cooperative has taken an encouraging stance on member-owned wind generators (of which there are 8 installed already in their service territory [see Appendix A of this paper]).

CONCLUSION

We have discussed some 200 Alternative and Supplemental Energy projects of Rural Electric Systems in the United States.[7] We do not claim to have covered all of the projects that they are engaged in. The United States is a very large country and news of everything that is happening does not always reach us. However, it is plain to see that the Rural Electric Systems are extremely active in all areas of Alternative and Supplemental Energy.

They are clearly able to see that, along with nuclear, large hydro and coal, we must develop these resources to help us achieve a secure energy future.

At NRECA we will continue to monitor and report on this activity and the progress of the Alternative and Supplemental Energy Technologies for the good of our member Rural Electric Systems. What they are doing in the United States will be valuable not only in America but also in the rest of the world which can share by their experiences.

FOOTNOTES

1. Other new energy sources have been investigated (i.e. Ocean Thermal Energy Conversion, Solar Satellite, Wave Energy, Tidal Energy, Fusion, etc.), but the Rural Electric Systems have no involvement in these. This is because they are still too far from commercialization or too exotic. This is the list of New Energy Technologies pertinent to the Rural Electric program.

2. A partial list of other projects in Rural Electric Service territories which Rural Electric Systems are only peripherally involved in is provided in Appendix A to give a feeling for the enormity of the scope of the overall effort in Rural America.

3. Note that in this paper peat (which is actually the first stage in coal formation) is treated as Biomass. This is simply a convenience and not an attempt at recategorization.

4. In the United States the official definition of "small" hydroelectric is a project of 25kW capacity or less. Note that we have included treatment of a number of "large" hydroelectric projects in this section, too. That is because they are part of the same phenomenon and motivated by the same forces and, therefore, belong in this section.

5. In the wind energy business a "large" wind machine is one that has a generating capacity of greater than or equal to 100kw. A "small" wind machine is one with less than 100kW generating capacity.

6. It is estimated that there are from 500-1000 small wind electric generators that have recently (in the last 10 years) been installed in Rural America. From this list the reader can see that we only know where 219 of them are located.

In addition, we know that there are far more biomass-fueled electric generating plants and mini and micro hydro plants than indicated here.

We estimate that this list represents approximately 1 out of every 5 installations of this type in Rural America. If that is the case, it should be a representative sample.

7. The total estimated generating capacity of these projects (should they all be carried through to completion) would be approximately 2040 Megawatts. In addition, there would be substantial fuels and BTUs produced by the Biofuels, Synfuels and Solar heating projects respectively. 105 Megawatts of this are already in place and producing electrical energy.

APPENDIX A

LIST OF KNOWN, PRIVATELY OWNED, ALTERNATIVELY OR SUPPLEMENTALLY FUELED ELECTRIC GENERATING INSTALLATIONS IN RURAL AMERICA AS OF MAY 1982

RURAL ELECTRIC SYSTEM (STATE)	TYPE/CAPACITY(kW)
Baldwin County EMC (ALABAMA)	Wind (4kW)
Alaska Village Electric Coop.	Wind (10kW)
"	Wind (2kW)
"	Wind (2kW)
Matanuska Electric Association (ALASKA)	Wind (10kW)
"	Wind (10kW)
"	Wind (10kW)
"	Wind (10kW)
"	Wind (2kW)
Naknek Electric Association (ALASKA)	Wind (1.8kW)
Sulphur Springs Valley Elec. Co-op (ARIZONA)	Wind (2kW)
"	Wind (2kW)
First Electric Cooperative (ARKANSAS)	Wind (1.5kW)
Plumas Sierra R.E.C. (CALIFORNIA)	Hydro (350kW)
"	Hydro (350kW)
"	Hydro (400kW)
"	Wind (10kW)
"	Geothermal/Biomass (10,000kW)
Holy Cross Elec. Assoc., Inc. (COLORADO)	Wind (40kW)
Intermountain R.E.A. (COLORADO	Wind (5kW)
"	Wind (8kW)
Mountain View Elec. Assoc. (COLORADO)	Wind (1.8kW)
"	Wind (1.8kW)
"	Wind (1.8kW)
"	Wind (1.8kW)
"	Wind (2kW)
"	Wind (4.8kW)
"	Wind (4.8kW)
"	Wind (15kW)
"	Wind (20kW)
Poudre Valley Rural Elec. Assn. (COLORADO)	Wind (3kW)
"	Wind (4kW)
"	Wind (4kW)
"	Wind (7.5kW)
San Luis Valley Rural Elec. (COLORADO)	Wind (2kW)
Union Rural Elec. Assn. (COLORADO)	Wind (5kW)
"	Wind (5kW)
"	Wind (4kW)
"	Wind (10kW)
YW Electric Assn. (COLORADO)	Wind (4kW)
"	Wind (1.5kW)
"	Wind (1.8kW)
"	Wind (4kW)
Peace River Electric Coop. Inc. (FLORIDA)	Wind (15kW)
Oglethorpe Power Coop. (GEORGIA)	Wood (7,000kW)
"	Hydro (600kW)
Troup County Elec. Membership Co. (GEORGIA)	Hydro (160kW)
Coles Moultrie Elec. Coop. (ILLINOIS)	Wind 1.5kW)
Corn Belt Electric Cooperative (ILLINOIS)	Wind (1.8kW)
M.J.M. Electric Cooperative (ILLINOIS)	Wind (1.8kW)
"	Wind (1.8kW)
Rural Elec. Convenience Coop. (ILLINOIS)	Coal Seam Gas (700kw

Shelby Electric Coop (ILLINOIS)	Wind (1.5kW)
White County EMC (INDIANA)	Wind (4kW)
"	Photovoltaics (2kW)
Alamakee Clayton Elec. Coop (IOWA)	Wind (10kW)
Buchanan County Rural Elec. Coop. (IOWA)	Wind (10kW)
Buena Vista County Coop (IOWA)	Wind (2kW)
Butler County REC (IOWA)	Wind (10kW)
Greene Cty. Rural Elec. Coop. (IOWA)	Wind (10kW)
Maqucketa Valley REC (IOWA)	WInd (10kW)
"	Wind (10kW)
South Crawford REC (IOWA)	Wind (20kW)
DS&O Cooperative (KANSAS)	Wind (2kW)
"	Wind (10kW)
Flint Hills Rural Elec. Coop. Assn. (KANSAS)	Wind (1.5kW)
Kaw Valley Elec. Coop. (KANSAS)	Wind (1.8kW)
"	Wind (10kW)
Lyon County Elec. Coop.(KANSAS)	Wind (2kW)
Midwest Energy, Inc. (KANSAS)	Wind (2kW)
"	Wind (2kW)
"	Wind (2kW)
"	Wind (5kW)
NCK Electric Coop. (KANSAS)	Wind (1.5kW)
Norton-Decatur Coop. (KANSAS)	Wind (10kW)
"	Wind (10kW)
Pioneer Electric Coop., Inc. (KANSAS)	Wind (25kW)
"	Wind (3.5kW)
PR&W Elec. Coop. Assn. (KANSAS)	Wind (4kW)
"	Wind (10kW)
Radiant Elec. Coop., Inc. (KANSAS)	Wind (4kW)
Smoky Hill Electric (KANSAS)	Wind (4kW)
"	Wind (4kW)
Victory Elec. Coop. (KANSAS)	Wind (4kW)
"	Wind (2kW)
Wheatland Electric Coop. (KANSAS)	Wind (15kW)
Farmers Rural Elec. Coop. (KENTUCKY)	Wood (100kW)
Cherryland Rural Elec. Coop. Assn. (MICHIGAN)	Wind (1.5kW)
"	Wind (1kW)
"	Wind (1.8kW)
"	Wind (1kW)
"	Wind (2kW)
"	Wind (25kW)
Northern Michigan Elec. Coop. (MICHIGAN)	Wind (25kW)
Top O' Michigan Rural Elec. Coop. (MICHIGAN)	Wind (1.8kW)
"	Wind (4kW)
"	Wind (10kW)
"	Wind (10kW)
"	Wind (10kW)
"	Wind (4kW)
"	Wind (1.5kW)
Tri-County Elec. Coop. (MICHIGAN)	Wind (1.5kW)
Agralite Cooperative (MINNESOTA)	Wind (5kW)
Anoka Elec. Coop. (MINNESOTA)	Wind (5kW)
"	Wind (2.5kW)
"	Wind (2.5kW)
"	Wind (10kW)

Anoka Elec. Coop. (MINNESOTA)	Wind 10kW)
"	Wind (3kW)
Cooperative Power Assn. (MINNESOTA)	Wind (4kW)
"	Wind (10kW)
Dakota Elec. Assn. (MINNESOTA)	Wind (20kW)
"	Wind (10kW)
"	Wind (10kW)
"	Wind (10kW)
East Central Elec. Assn. (MINNESOTA)	Wind (1.8kW0
"	Wind (10kW)
Frost-Benco Electric (MINNESOTA)	Wind (10kW)
Goodhue County Coop. Elec. Assn. (MINNESOTA)	Wind (10kW)
"	Wind (10kW)
"	Biomass (15kW)
Northern Electric Coop. (MINNESOTA)	Peat (100kW)
"	Wind (4kW)
North Star Elec. Coop., Inc. (MINNESOTA)	Wind (4kW)
"	Wind (4kW)
People's Coop Power (MINNESOTA)	Wind (10kW)
"	Wind (10kW)
PKM Electric Coop. (MINNESOTA)	Wind (1.8kW)
"	Wind (4kW)
Red River Valley Coop. Power Assn. (MINNESOTA)	Wind (5kW)
Renville Sibly Coop. Power Assn. (MINNESOTA)	Wind (10kW)
Southwest Minnesota Coop. (MINNESOTA)	Wind (10kW)
"	Wind (10kW)
"	Wind (20kW)
Traverse Elec. Coop. (MINNESOTA)	Wind (10kW)
"	Wind (2kW)
United Power Assn. (MINNESOTA)	Wind (1kW)
"	Wind (10kW)
Wild Rice Elec. Coop. Inc. (MINNESOTA)	Wind (2kW)
"	Wind (2.5kW)
"	Wind (2.5kW)
Wright-Hennepin Coop. (MINNESOTA)	Wind (10kW)
"	Wind (10kW)
Coast Elec. Power Assn. (MISSISSIPPI)	Wind (1.5kW)
"	Wind (1.5kW)
Boone Elec. Coop. (MISSOURI)	Biomass (21kW
Cent. Montana G&T Coop. (MONTANA)	Wind (2kW)
Sun River Elec. Coop. (MONTANA)	Hydro (16kW)
Dawson County P.P.D. (NEBRASKA)	Wind (10kW)
"	Wind (8kW)
Niobra Valley E.M.C. (NEBRASKA)	Wind (8kW)
Seward County Public Pwr. Dist. (NEBRASKA)	Wind (4kW)
"	Wind (5kW)
Wells Rural Elec. Coop. (NEVADA)	Hydro (300kW)
Central New Mexico Elec. Coop. (NEW MEXICO)	Wind (25kW)
Farmer's Elec. Coop. (NEW MEXICO)	Wind (25kW)
"	Wind (15kW)
Jemez Mountains Elec. Coop. (NEW MEXICO)	Wind (10kW)
Lea County Elec. Coop. (NEW MEXICO)	Wind (25kW)
Mora-San Miguel Elec. Coop. (NEW MEXICO)	Wind (1kW)
Springer Elec. Coop. (NEW MEXICO)	Wind (4kW)
"	Wind (10kW)

Springer Elec. Coop. (NEW MEXICO)	Wind (4kW)
"	Wind (10kW)
"	Wind (5kW)
"	Wind (5kW)
Blue Ridge E.M.C. (NORTH CAROLINA)	Hydro (911kW)
Carteret-Craven E.M.C. (NORTH CAROLINA)	Wind (1.5kW)
Crescent Elec. Membership Co. (NORTH CAROLINA)	Hydro (30kW)
Jones Onskio Elec. Memb. Co. (NORTH CAROLINA)	Wind (1kW)
Jones Onslow E.M.C. (NORTH CAROLINA)	Wind (4kW)
McLean Elec. Coop. (NORTH DAKOTA)	Wind (1kW)
Mor-Gan-Sou Elec. Coop. (NORTH DAKOTA)	Wind (10kW)
"	Wind (10kW)
"	Wind (25kW)
Oliver Mercer Elec. Coop. (NORTH DAKOTA)	Wind (10kW)
Busler Rural Elec. Coop. (OHIO)	Wind (4kW)
Holmes-Wayne Electric Coop. (OHIO)	Biomass (1400kw)
Caddo Electric Coop. (OKLAHOMA)	Wind (1kW)
"	Wind (2kW)
"	Wind (1kW)
Canadian Valley Elec. Coop. (OKLAHOMA)	Wind (1kW)
"	Wind (1kW)
"	Wind (1kW)
"	Wind (4kW)
Central Rural Elec. Coop. (OKLAHOMA)	Wind (4kW)
"	Wind (1kW)
Cotton Electric Cooperative (OKLAHOMA)	Wind (1kW)
E. Central Oklahoma Elec. Coop. (OKLAHOMA)	Wind (10kW)
Oklahoma Elec Coop. (OKLAHOMA)	Wind (1kW)
"	Wind (1kW)
Rural Electric Cooperative (OKLAHOMA)	Wind (1kW)
"	Wind (1kW)
"	Wind (1kW)
Southwest Electric Coop. (OKLAHOMA)	Wind (8kW)
Tri-County Elec. Coop. (OKLAHOMA)	Wind (10kW)
Consumers Power, Inc. (OREGON)	Hydro (2kW)
Coos Curry Elec. Coop. (OREGON)	Wind (10kW)
"	Wind (2kW)
Tillamook Public Util. Dist. (OREGON)	Hydro (2kW)
"	Wind (1.5kW)
Somerset Rural Elec. Coop. (PENNSYLVANIA)	Wind (1.8kW)
Sullivan Cty. Rural Elec. Coop. (PENNSYLVANIA)	Biomass (150 kW)
Cherry-Todd Elec. Coop. (SOUTH DAKOTA)	Hydro (235kW)
Spink Elec. Coop. (SOUTH DAKOTA)	Wind (10kW)
Caney Fork Elec. Coop. (TENNESSEE)	Biomass (125kW)
Bandera Elec. Coop. (TEXAS)	Wind (3kW)
Deaf Smith Elec. Coop. (TEXAS)	Wind (4kW)
Guadelupe Valley Elec. Coop. (TEXAS)	Wind (2kW)
"	Wind (2kW)
J.A.C. Elec. Coop. Assn. (TEXAS)	Wind (10kW)
"	Wind (25kW)
"	Wind (25kW)
"	Wind (25kW)
Lyntegar Elec. Coop. (TEXAS)	Wind (4kW)
Mid South Electric Coop. Assn. (TEXAS)	Wind (5kW)
South Plains Elec. Coop. (TEXAS)	Photovoltaics (5kW)

Swisher Elec. Coop. (TEXAS)	Wind (25k)
"	Wind (25kW)
"	Wind (25k)
Tri-County Electric Coop., Inc. (TEXAS)	Wind (1.8kW)
Victoria Elec. Coop. (TEXAS)	Wind (1.8kW)
"	Wind (1.8kW)
"	Wind (4kW)
Wise Electric Coop. (TEXAS)	Wind (1.5kW)
"	Wind (4kW)
"	Wind (25kW)
Garkane Power Assn. (UTAH)	Wind (4kW)
Vermont Elec. Coop. (VERMONT)	Hydro (12kW)
"	Hydro (15kW)
"	Hydro (5kW)
Klickitat Public Util. Dist. (WASHINGTON)	Wind (2kW)
"	Wind (2kW)
"	Wind (2kW)
"	Wind (4kW)
Adams-Marquette Elec. Coop. (WISCONSIN)	Wind (4kW)
"	Wind (4kW)
Allamakee Clayton Elec. (WISCONSIN)	Wind (10kW)
Barron Elec. Coop. (WISCONSIN)	Wind (10kW)
"	Wind (10kW)
Bayfield Electric Coop. (WISCONSIN)	Wind (40kW)
Crawford Elec. Coop. (WISCONSIN)	Wind (1.5kW)
Eau Claire Elec. Coop. (WISCONSIN)	Wind (1.5kW)
Oconto Electric Coop. (WISCONSIN)	Hydro (75kW)
"	Wind (6kW)
"	Wind (30kW)
Peoples Power Assn. (WISCONSIN)	Wind (10kW)
"	Wind (10kW)
Rock County Elec. Coop. (WISCONSIN)	Wind (10kW)
St. Croix County Elec. Coop. (WISCONSIN)	Wind (10kW)
Trempealeu Electric Coop. (WISCONSIN)	Wind (1.5kW)
Carbon Power and Light (WYOMING)	Wind (1.5kW)